3D Strain Mapping by Phasing of Coherent X-ray Diffraction Patterns

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The brilliance of third generation synchrotron sources provide sufficient coherent flux that the diffraction from a single coherence volume can be readily measured. If the either the beam or the sample is smaller than a coherence volume, then the diffraction from the illuminated sample is the Fourier transform of the electron density of the sample times the illumination function. The phase which is lost in the measurement process can be recovered through use of iterative alrgorithms, pioneered by Gerchber and Saxton and developed further by Fienup, given that an upper bound on the extent of the illuminated sample is known. Phasing the diffraction pattern is equivalent to recovering the scattering density of the sample. In the case of transmission, this density is purely real. In the case of diffraction, the density is a complex value, where the phase is the local strain in a crystal projected onto the scattering vector. We present here the first application of this technique to diffraction from individual sub-micron Pb particles to recover a three dimensional map of the strain in a nanocrystal.